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Kenis, P.N.; Oerlemans, L.A.G.

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CHAPTER 11

THE SOCIAL NETWORK PERSPECTIVE

UNDERSTANDING THE STRUCTURE OF COOPERATION

PATRICK KENIS
LEON OERLEMANS

The Origins and Use of the Social Network Perspective

The social network perspective refers to a tradition in social science which focuses on the joint activities of, and continual exchanges between, participants in a social system. This perspective is characterized by an interest in the recurrent relationship patterns that connect the actors that make up a system's social structure. (See Wellman 1988 and Freeman 2004 for detailed explanations of the origins of this perspective.) What we now consider the social network approach is a combination of ideas drawn from the structuralist network tradition (Berkowitz 1982; Wellman

and Berkowitz 1988) and more recent thinking, particularly the *embeddedness* (Granovetter 1985) and *social capital* perspectives (Burt 2005).

Probably the single most important concept in a social network approach is the relationship among actors, be they individuals or in groups such as whole organizations or parts of organizations. Rather than examining actors in isolation, the social network perspective sees actors as embedded within networks of interconnected relationships that provide opportunities for, as well as constraints on, behaviour. The focus is on the interaction between actors rather than on the attributes of particular actors, their size for example. Thus the social network perspective represents a move 'away from individualist, essentialist and atomistic explanations toward more relational, contextual and systematic understanding' (Borgatti and Foster 2003: 991).

A considerable number of ideas, concepts, and research questions which we will introduce below have unfolded from this essential notion. We look briefly at some of them. (For more comprehensive overviews, see Borgatti and Foster 2003; Brass *et al.* 2004; Kilduff and Tsai 2003; Baker and Faulkner 2002; Kilduff *et al.* 2006.)

As we have said, it is the relationships between actors and not their attributes which is important. This is the 'core belief that underlies modern social network analysis', as Freeman (2004: 16) has put it. As a result, considerable work has gone into characterizing and specifying these relationships. The key components of a social network approach are: actors, ties and dyads, egocentric network, complete network, positional properties of actors in networks, and structural properties of networks. These elements will be central to our discussion. Let us provide a short introduction to these concepts for those who are not familiar with the social network approach.

Actors in networks, also called *nodes* or *vertices*, can be persons or teams, organizations, countries, regions, and so on. In the field of inter-organizational relations we focus, by definition, on relationships between organizations. Inter-organizational relationships will, however, often be measured at a different level, for instance at that of individuals in the case of an interlocking directorate, when a person affiliated with one organization also sits on the board of directors of another organization (Mizruchi 1996).

Another salient issue in a social network approach is the identification of actors, that is who is a part of a network, and who is not, the so-called issue of boundary specification. The answer to this question can influence considerably the structural properties of the network. For instance, including only companies of a certain minimum size in an innovation network runs the risk of excluding the most central player, say a small company that recently introduced a radical innovation, thus producing an unreliable picture of the structure of the innovation network.

Two strategies are commonly used to specify the boundary of networks, a nominalist strategy and a realist strategy, though the two can be combined (see Knoke and Laumann 1982). A nominalist strategy defines the boundaries in terms of the

interest of a researcher or of a policy-maker, for example who is the central player in a certain industry or among Fortune 500 companies. A realist strategy defines the boundaries in terms of what network participants in a specific situation themselves think are the boundaries of the network in a specific situation, for example a network of those who believe that they influence the decision whether a given drug is approved.

We said earlier that relationships among actors are probably the central concept in a social network approach. These ties are also called *relations*, *lines*, or *edges*. Dyadic ties connect pairs of actors and define the substantive relationships that exist between ego (the focal organization) and the alters (those related to ego). They can range from friendships and social contacts to formal contracts, working relationships, giving and/or receiving advice, interlocking directorates, etc. In contrast to arm's-length market relationships, which can also be considered ties, the relationships in a network approach are relatively stable, although less so than in a hierarchy. It is clear that any dyad or network is constituted of multiple types of relationships. What is important, however, is what the researcher expects to find useful for understanding important actor and system behaviour. For instance, if a researcher is interested in the degree of cohesion in a knowledge network, he will collect data on the degree to which actors know what somebody else in the network knows and not on the formal relationships. Not only the type of relationship is important but also whether they are directed, for example advice-giving, or undirected, informal communication for instance, and what the extent of the tie is. For the most part, the magnitude of the tie is, however, measured dichotomously, that is by the presence or absence of a tie. Tie strength can also be potentially measured in a more detailed way by assigning scalar values to each existing dyad to reflect the relative strength or weakness of a tie. Granovetter's 1973 classic article, 'The Strength of Weak Ties', in which he demonstrates that weak ties actually provide the strongest pathways to finding a job, provides a good example. Tie strength being defined as the combination of time, emotional intensity, the intimacy, and the reciprocal services which characterize the tie (Granovetter 1973).

The notable strength of the social network approach is that it goes beyond the sole consideration of dyads to that of the sum of the dyads. The social network approach's particular strength is that it has developed a considerable number of measures of system connectedness which describe the structural properties of networks. According to Emirbayer and Goodwin the principal achievement of network analysis 'has been to transform a merely metaphorical understanding of the embeddedness of actors in networks of social relationships into a more precise and usable tool for social analysis' (1994: 1446). It is now possible to operationalize and measure the relational and structural properties of social and organizational systems and the encompassing units by collecting data on virtually any social relation between units. A consequence of all this is that a network has become a variable. Rather than using the network concept metaphorically, we are now able to distinguish different

types of networks and network structures, based on the presence and absence of relationships, and we can thus demonstrate that different outcomes can be expected given the configuration of the network.

The structure of relations among actors in the network has consequences both for individual units in the network and for the system as a whole. Many measures are available to describe the structural position of actors within networks, such as centrality, distance, structural equivalence, etc., as well as the structural properties of the network as a whole, including volume, density, centralization, cliques, and so forth (see Wasserman and Faust 1994).

Even more importantly, we now have a vast number of studies that demonstrate the significance of the positional properties of actors in networks and structural properties of the whole network on a myriad of outcomes. (For reviews of the organizational literature on this topic see Borgatti and Foster 2003; Brass *et al.* 2004; Kilduff and Tsai 2003; Baker and Faulkner 2002; Oliver and Ebers 1998; Freeman 2004; and Kilduff *et al.* 2006). In addition, the descriptive structuralist network approach has been further validated by important theoretical developments, especially social capital and embeddedness theories (see e.g. Burt 2005).

As observed by Borgatti and Foster (2003), the social capital concept helped to fuel interest in social networks. Social capital is, in the most general sense, a measure for an actor of the value of his social connections (see also, Nahapiet, Chapter 22 this volume). Although it is clear that the concept underlies the importance of relations between actors, mainly from a resource perspective, social capital itself can also be considered from a more genuine social network perspective. Both Burt (1992) and Coleman (1990) have introduced a topological view of social capital that emphasizes the importance of the interconnections among the members of a whole network. While Burt focuses traditionally on the absence and presence of links among the alters of a specific ego in the network (the so-called brokerage perspective), Coleman concentrates on the absence and presence of links among all network participants (the so-called closure perspective). From a brokerage perspective (Burt), an actor or a dyad in a network can derive control benefits from being situated between two other organizational entities, for example, a dyad that links two previously unconnected parts of a network. Actors or inter-organizational relations (IOR) in this role can generate benefits for themselves which can translate into favourable conditions in their exchanges with other actors (Burt 1992). Furthermore, having a central position in the network can produce a favourable reputation which in turn can lead to advantages in tie formation. For example, the fact that several scholars find support for processes of homophily wherein more centrally positioned organizations are more likely to form ties with organizations of similar status (Amburgey and Al-Laham 2006). From a closure perspective (Coleman) third parties create social capital by improving information flow, making it possible to detect and punish bad behaviour (Burt 2005). Recently, Burt suggested that the tension between these two perspectives can be solved by integrating both mechanisms (e.g. brokerage and

closure) in a broader model (Burt 2005). He suggests that bridging a structural hole can create value if there is a closed network of a cohesive team around the bridge. Structural holes are the empty spaces in a social structure which implies that actors on either side of a structural hole circulate in different flows of information. Value is thus created in the case where a structurally autonomous group consists of people strongly connected to one another, with extensive bridge relations beyond the group.

The theory of embeddedness, as originally formulated by Granovetter (1985), emphasizes that economic exchanges are embedded in social networks (see also Jones and Lichtenstein, Chapter 9 this volume). They are neither purely role-based, oversocialized behaviour, nor are they strictly instrumental rational, undersocialized behaviour. Embeddedness refers to (1) that actors prefer to interact with family members, friends, and acquaintances rather than with persons they do not know, (2) that social ties are nested in other ties, and (3) that previous ties influence the development of future ones (see Granovetter 1985, 1992, 2005; Swedberg 1994; Powell and Smith-Doerr 1994).

For example, the embeddedness argument emphasizes mechanisms through which informational advantages are produced. Relational embeddedness, which essentially refers to the quality and depth of a single dyadic tie, stresses the importance of direct cohesive ties as a mechanism for obtaining fine-grained information (Uzzi 1996). Actors that share direct connections are likely to possess comparable knowledge and information, leading to shared understandings which influence behaviours, imitation for example. Relational embeddedness can also be regarded as the capacity for ties to carry information that decreases uncertainty levels and produces trust between entities (Burt and Knez 1995). To summarize, relational embeddedness can generate unique information on the capabilities and reliability of other actors which are part of the network.

Structural embeddedness, on the other hand, stresses the informational value of the structural positions that actors have in networks. Structural embeddedness refers to the fact that organizations do not just have relationships with each other but also with the same third parties. A consequence of which is that actors are linked indirectly by third parties. The more structural embeddedness there is in a network, the more information about each actor is known to all other actors. Moreover, actors situated between distinct groupings can derive advantages from their positions for themselves and can broker relationships among other players. As such, benefits are created for the networks as a whole, by improving interim coordination and information flow.

It is from the latter perspective that we will analyse the contribution of a network approach to the study of inter-organizational relations. Through a comprehensive review of the academic literature using Web of Science, we identified research on inter-organizational relations in which a network perspective is prevalent. While the phenomenon of formation of inter-organizational relations is addressed in that

literature, other aspects of inter-organizational relations, such as their effectiveness, have received very little attention. Consequently, this review only reflects what is available in the literature and not what could be done. We will come back to that later.

Tie Formation as a Consequence of Networks

Tie formation is the most commonly studied phenomenon within a network approach. This is understandable as scholars who have affinity with the network perspective see the presence or absence of relationships as one of the main characteristics of networks. The literature has identified a considerable number of factors pertaining to why organizations form ties (see Oliver 1990; Ebers 1999). We concentrate here specifically on the factors associated with the network approach. How do networks influence whether a firm forms a link? In the literature two distinct network approaches could be identified which explain why ties are formed: embedded tie formation and non-local tie formation. We address these approaches subsequently.

Embedded or Local Tie Formation

The idea of the embedded tie formation approach is that the characteristics of a particular network (also called local network) influence the likelihood of organizations forming ties as well as the likelihood that two specific actors within that network will form a relationship (Gulati 1995; Powell *et al.* 1996; Gulati and Gargulio 1999).

For example, Walker, Kogut, and Shan (1997) demonstrate that the study of inter-firm cooperative agreements in the biotechnology industry requires an analysis of the network as a whole because network formation is a result of two opposite forces: the reproduction of the network structure as a general social capital source for members of the network and the alteration of the network structure by entrepreneurs for their own benefit. They show that it is the amount of social capital, itself a function of the firm's position in the network, that explains the formation of new relationships among biotechnology start-ups. It turns out that biotechnology start-ups choose to increase firm relationships in order to increase their social capital rather than to exploit structural holes for self-interest. The underlying rationale for this strategy is that social capital is more valuable than maximizing entrepreneurial opportunities. In other words, structural stability and mutual dependence in such

networks is viewed as more important and would be jeopardized by self-interested behaviour.

Other studies have found that the network structure is a repository of information and therefore is used in deciding with whom to build a new tie in that risk and uncertainty are fundamental to partner selection (Williamson 1975; Pfeffer and Salançik 1978; Kogut 1988; Podolny 1994; Gulati 1995; Gulati and Gargiulo 1999). Organizations tend to select partners with whom they are familiar and on whom they are likely to have rich information. A useful source of such information seems to be the network in which the organizations are mutually embedded. Consequently, organizations will choose relationships with partners within their own network.

In the literature it is argued that an organization can derive information from the network in which it is embedded. The network embodies different sources of information. Organizations can use information based on their direct relations in the network, about the structure of the network or about the position of actors within the network.

First, organizations have information on partners with whom they have, or have had, a relationship, what has been called *relational embeddedness* (Gulati and Gargiulo 1999). Repeated ties provide information on the capabilities, reliability, and interests of potential partners and therefore what can be expected in future interactions (Podolny 1994; Uzzi 1997; Walker *et al.* 1997; Axelrod 1984; Larson 1992; Gulati 1995). Although the network effect seems limited here as information is mainly based on previous bilateral experiences, one could also argue that the more experience an organization has had with existing network partners the more likely it is that a new relationship will develop within the same network. Ahuja (2000*a*) presents a convincing rationale for how different forms of capital, technical, commercial, or social, explain linkage formation. He demonstrates that all of these forms of capital are *inducements* to linkage formation.

Second, organizations tend to select their partner's partner (Burt and Knez 1995; Baker 1990; Uzzi 1996), what has been called structural embeddedness (Gulati and Gargiulo 1999). In contrast to the previous case, here a genuine network effect exists. The frame of reference shifts from direct contacts to indirect channels of information, reputation, and referral. Such information can only result from a network structure. When organizations A and B share a common partner C, then A and B are more likely to form a relationship between themselves as they see the trust placed in each of them by C. In the absence of first-hand experience then, information based on indirect linkages is seen as a good alternative (Podolny 1994; Uzzi 1996; Gulati and Gargiulo 1999).

The *field-net* approach is a further specification of the structural embeddedness approach. It considers the structural characteristics of a network at time 1 to affect tie formation at time 2 (Kenis and Knoke 2002). In this context, a field-net is defined as the configuration of present and absent IORs among all the organizations that are members of an organizational field. The field-net concept is a network application

of the organizational field concept as developed by DiMaggio and Powell, who stated that an organizational field comprises 'those organizations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, producers, regulatory agencies, and other organizations that produce similar services or products' (1983: 148). Primarily on the basis of theoretical insights and empirical studies from the field of network analysis, they formulate propositions on how density, reciprocity, confirmation of ties, connectivity, centralization, multiplexity, cohesion, and network hierarchy affect tie formation within the field-net. The field-net approach assumes that the macro-level configuration of inter-organizational ties among field members serves as an opportunity structure that both constrains and facilitates the potential actions of member organizations. Kenis and Knoke (2002) emphasize how aggregate relations within a field-net can erect substantial barriers to collective action, for example, that more centralized networks provide fewer opportunities for peripheral participants to locate potential partners with whom to forge new collaborative ties.

A third available source of information for partner selection is the network position of potential partners, the so-called *positional embeddedness* (Gulati and Gargiulo 1999). Positional embeddedness refers to the fact that the position of an organization in a network influences its ability to access information about potential partners as well as its visibility and its attractiveness to other organizations. In the absence of first-hand experience or recommendations by third parties, organizations can make inferences about the quality of a potential partner (Podolny 1994; Podolny and Phillips 1996). Gulati and Gargiulo (1999) have demonstrated that the network position plays an important role in partner selection. The more central an actor's network position, the more likely that it will have better information about a larger pool of potential partners, and hence that it will select a partner. At the same time, central actors are themselves more attractive to potential partners as their central position signals their willingness, experience, and ability to enter into partnerships. This signalling property is found in research to be particularly important in uncertain environments, because it presents reputational differences among organizations that extend beyond their immediate circle of direct (as described by relational embeddedness) and indirect ties (as described by structural embeddedness). Consequently, one can expect that organizations which have a similar central position are more likely to build a new relationship among themselves.

In summary, being embedded in a network encourages an organization to cooperate more with other member organizations as opposed to with those outside. Hence networks are considered as a repository of information on the availability, competencies, and reliability of prospective partners (Burt 1992; Kogut *et al.* 1992; Gulati 1995; Powell *et al.* 1996).

Ahuja (2000*a*) has, however, emphasized that embeddedness exerts two contradictory influences on a firm's incentives to form linkages. On the one hand, a history of dense linkages provides a firm with expertise in managing such linkages,

but on the other, there could be saturation. Every linkage that embeds a firm more deeply in the network also places a strain on its management and absorptive capacity. Consequently Ahuja proposes a curvilinear relationship between the level of embeddedness and tie formation.

Non-local Tie Formation

A second context in which ties form within a network approach is what we call non-local ties. Non-local ties are ties with actors outside the network in order to expand the network (Pfeffer and Salançik 1978) by incorporating new actors (see also Burt 1983; Gargiulo 1993), for example, to learn about new practices and technologies (Kogut 1988; Powell *et al.* 1996). This perspective is somewhat in contrast to an embeddedness perspective in which past interactions or the characteristics of the local network play an important role.

This perspective can throw light on how firms that have not previously formed relationships with other organizations, for example new entrants into an industry, gain first entry into networks, a topic which has also been outside the purview of extant empirical embeddedness studies. For example, Ozcan and Eisenhardt (2006) find evidence for the fact that ties can form between firms with no prior connection. In particular, firms with limited resources can form ties with prominent partners if the latter can be approached in the early stages of an industry. Early tie formation gives low-power firms the opportunity to collaborate with prominent players in the co-creation of the market. In contrast, newcomers who approach prominent firms later often find them too busy to pay any attention to them. This research shows the importance of strategy, and particularly of timing, as important variables in explaining tie formation (Ozcan and Eisenhardt 2006).

In a study of the 300 largest US firms, Beckman, Haunschild, and Philips (2004) have also empirically demonstrated the importance of non-local relationships, or what they call relationships with strangers. At the same time they also identified local relationships, or as they put it, relationships with friends. They demonstrate in their analysis that firms form new relationships with new partners to explore and that they form additional relationships with existing partners to exploit (March 1991). Whether exploration or exploitation is chosen depends on the uncertainty that a firm is facing. This study relates to another variant of the non-local tie formation perspective, the *Small World tie formation* perspective. This perspective also points towards the phenomenon that previously unrelated actors form ties. It is, however, more specific with regard to the type of non-local ties formed and the reason why such ties are formed. The ties central in the small world tie formation perspective are those formed between locally clustered networks. These are called 'small world structures' and refer to densely interconnected local substructures

linked by a few intermediaries (Nohria and Garcia-Pont 1991; Kogut and Walker 2001; Baum *et al.* 2003; Davis *et al.* 2003; Powell *et al.* 2005; Burt 2005). The reasons why ties are formed between such substructures is not accidentally or merely related to instrumental considerations but is also related to social reasons. For example, the reason why two actors (who are part of different substructures) are participating in the same event and learn that the two have a mutual friend ('Isn't it a small world?') describes the often observed tendency for actors at geographically removed locations to be connected through intermediaries.

Also the literature on interlocking directories has demonstrated the importance of key intermediaries and the small world of companies in specific economies. An interlocking directorate occurs when a person connected to one organization is a member of the board of directors of another organization. Such intermediaries facilitate collusion (Pennings 1980), deal with interfirm resource dependencies (Boyd 1990), and are used to monitor inter-organizational behaviours and to exert power. For example, a bank might stipulate that one of its own board members be put on the board of a client with a high debt ratio for monitoring reasons. Finally, interlocks with important organizations are formed to signal to other stakeholders, for example investors, that the firm is a legitimate enterprise worthy of financial support.

Ties between small worlds thus create channels for information exchange across local clusters (Baum *et al.* 2005). They can transform a locally clustered network into a small world in which any two members have short connecting paths (Watts 1999). These networks enable efficient access to diverse information across locally clustered networks while maintaining the benefits of embedded ties within local clusters.

There is little research that explains the small world characteristic of inter-organizational networks. Baum *et al.* (2005) suggest that the effects of performance feedback might explain such partnering strategy. In contrast to the classic embedded relationship, this type of relationship is characterized by risk and uncertainty. They demonstrate that organizations performing far from historical and social aspirations are more willing to accept the uncertainty and risk of such non-local ties with relative strangers. Inconsistent performance feedback triggers the greatest risk in selecting partners. This conclusion cannot be considered as evidence in favour of a network approach since in the first place it is attribute variables which explain whether actors form ties or not. Nonetheless, the study is still important in this context as it demonstrates that the characteristics of the local network are not necessarily the dominant explanation for forming ties. The study is also relevant because it explains that IORs result from forming ties between networks, the rationale being that non-redundant ties can provide unique information and can create opportunities to broker resource and information flows across previously unconnected (clusters of) partners (Burt 1992, 2005; Ahuja 2000*a*; Rowley *et al.* 2000; Soda *et al.* 2004).

The research presented above has mainly addressed the question of with whom within their existing network an actor will form a relationship. It thus complements the literature which explains the actual formation of networks by exogenous factors such as the distribution of technological resources or the structure of resource dependence (Pfeffer and Salançik 1978; Burt 1983). A network approach actually challenges this literature since it provides an alternative explanation for tie formation. Gulati (1999) introduced the concept of *firm network resource*. This is an information resource which firms obtain from the inter-firm networks in which they are located. The number of such resources available to firms can influence their strategic behaviour because it alters their opportunity sets. In general, it is argued that the richer the information, the larger the opportunity set available. Consequently, one can show empirically that the extent to which firms enter into new relationships is influenced by these resources. Gulati (1999) also has shown that these network resources, measured by firms' location in the inter-firm network of prior ties in which they are embedded, are more important than other factors such as the length of time since a firm had last entered into an alliance and the diversity of their alliance portfolio in terms of governance structures used and nationalities of partners involved. This might point to the fact that once firms have developed the administrative control procedures for creating new alliances, they are able to use that knowledge in any kind of alliance.

Tie Termination

Tie termination is as interesting as tie formation, and yet it has prompted very little research from a social network perspective (Gulati 1998). Just as there is in the network literature an analytical bias towards the presence of relationships to the detriment of the absence of relationships, there also seems to be a bias towards the formation of ties compared to their termination. Nevertheless, the termination of ties is as important as their formation, especially since both are affected by the performance of organizations. Tie termination is also important for understanding partnering behaviour and network dynamics (Podolny and Page 1988; Uzzi 1996). From a theoretical point of view, whether the theories that explain the formation of ties can also explain their termination is also of interest.

There are several reasons why tie termination has received less attention from scholars in the field. First, there is a construct validity problem: tie failure and tie termination are often not distinguished. However, there is a difference between natural and untimely tie terminations. Many successful IORs are terminated because partners have planned to do so from the very start. Moreover, an IOR might be

used as a transitional organizational arrangement that is terminated as soon as its goals are accomplished or when the participating partners have new information that makes an acquisition feasible (Balakrishnan and Koza 1993). Furthermore, not all ongoing IORs are successful. Some may be continuing because of inertia or high exit costs associated with tie termination (Kim *et al.* 2006).

Second, there is an internal validity problem that results from the dyadic nature of IORs. Several scholars argue that the developmental process of dyadic inter-organizational relationships impact on how these relationships emerge, evolve, and dissolve. More specifically, they propose that imbalances in this process impact on the probability of tie termination. Ring and Van de Ven (1994) state that tie termination is a result of imbalances between actors, for example due to alternations in organizational commitment. However, Chen and Chen (2002) show that in IORs between organizations located in developed and emerging economies, imbalances in the actual distribution of outcomes are regarded as part of the deal due to the different motives the partners have when entering an IOR and thus do not increase the probability of tie termination.

Despite these difficulties, several scholars have studied the termination of IORs from a network perspective. There is some evidence that IORs with more embedded ties may perform better or last longer than those without. Kogut (1989) found that IORs between partners with a prior history of ties are less likely to terminate. Levinthal and Fichman (1988) and Seabright, Levinthal, and Fichman (1992) found that IOR duration is not only influenced by changes in resources dependencies but also by higher levels of relational embeddedness in the network. This embeddedness leads to tie persistence because actors have a shared history of collaboration. However, the few studies that have addressed tie termination from a network perspective focus predominantly on the effects of relational embeddedness. Therefore, we know little about the impact of structural embeddeness on termination.

One study that looks at the relationship between structural embeddedness and tie termination is that of Amburgey and Al-Laham (2006). They specify different types of tie failure, namely the failure of a tie that is (*a*) a bridging tie, which is a tie that connects two components in a network; (*b*) a pendant tie, one which is between a firm and a firm with high centrality not in the network; (*c*) an intra-component tie, which is a tie in a component of a network; and (*d*) a dyad. Moreover, they distinguish network components, which are parts of a network in which actors are actually connected. Next, they relate these different types of tie failure to the structural cohesion or density of a network component and formulate a number of hypotheses which can be summarized as follows: The higher the density level of a network component, that is the higher the ratio of actual ties to the number of possible ties, the higher the likelihood of tie termination of (*a*) a bridging tie; (*b*) a dyad; (*c*) a pendant tie. However, the likelihood of so-called component-thinning terminations, for example, terminations within a network component, increases with the number of intra-component ties. These hypotheses were tested with a

longitudinal research design including biotechnology R&D alliances in the USA and Germany. With the exception of the hypothesis on the termination of pendant ties, all hypotheses were empirically confirmed. These findings highlight the notion that changes in the structure of networks clearly have an impact on tie termination rates.

Tie Functioning and Network Effects

The functioning of IORs has also been rarely studied from a network perspective. By functioning we mean the management, monitoring, and control of ties (see also Hibbert *et al.* Chapter 15 this volume). The major assumption is that the factors that have a positive influence on tie formation will also have a positive effect on their functioning. Repeated ties also contribute to the development of a common language and common routines that facilitate the joint planning, rich information exchange, and conflict resolution skills required for successful partnerships (Mohr and Spekman 1996; Simonin 1997; Inkpen and Dinur 1998; Zollo *et al.* 2002). Repeated ties also facilitate the collective monitoring and sanctioning of deviant behaviour among partners, which fosters a concern for local reputation (Burt and Knez 1995, Rowley 1997; Walker *et al.* 1997).

It is clear that this is an unsatisfactory situation. The simple fact that the majority of ties which emerge are terminated after some time because they are dysfunctional shows that the factors that positively influence the formation of ties must be different from those that explain their functioning.

As suggested by Gulati (1999: 415), it could be the case that 'network resources resulting from the network of prior alliances not only provide powerful enabling conditions for firms to enter new alliances, it can also have consequences for the relative success of individual alliances the firm enters'. It would indeed be interesting to compare IORs which result from an embeddedness rationale with IORs which have been formed on the basis of another rationale in order to see whether these vary in functioning and effectiveness.

Ozcan and Eisenhardt (2006) have demonstrated that strong portfolios, for example a diversified egocentric network of alliances, are those which have redundant ties. Entrepreneurial firms in a nascent market are more likely to build a strong portfolio if they manage ties with several firms of each type. These help to provide information and maintain alternative courses of action. Basically, this finding relates to the discussion in the literature on trade-offs between the number and the strength of ties. Hansen (1999) suggested that a unit can have either a high number of weak ties or a low number of strong ties. Ozcan and Eisenhardt found that firms with strong tie portfolios only work intensively with their most

active partners while creating through frequent communication the appearance of interest with their other partners. They call this the sequential-attention approach. Another factor mentioned here is that a strong portfolio is related to avoiding ties with competitors. Such ties are inherently unstable and if the relationships are terminated, the negative effect of the relationship on the rest of the portfolio is often not easily undone.

Another issue which has received attention in this context is tie depth, which refers to the level of interaction taking place within ties. There are only a few studies which consider tie depth and how it evolves over time. Larson (1992) and Doz (1996) show that tie depth grows over time as partners build mutual trust. Ozcan and Eisenhardt (2006) confirm this finding but also observe that deep ties can become shallow over time. When a tie becomes insignificant to one of the partners, that partner may decide to decrease the level of interaction rather than discontinue the relationship altogether. The tie can be revitalized at a later stage. Another finding of Ozcan and Eisenhardt (2006) confirming the network approach is that ties do not only become deep due to the improvements in the relationship between partners, but also because they evolve along with other ties in the network. Ties of different types evolve along with other ties based on the interdependence between them. Ozcan and Eisenhardt show that low-power firms are able to maintain strong portfolios, for instance portfolios with deep ties to many prominent members, which help them to overcome their disadvantages, attract other prominent partners, and increase their sales. As a result, they are able to improve their structural position in the network, that is, they become more central.

The above relates to the more general issue of the effects of networks on their member organizations. Participating in a network provides members of IORs with opportunities for sharing a variety of resources. As network ties are conduits of information transmission, they give organizations trusted information that affects their behaviours. This information could lead to imitation of practices (Henisz and Delios 2001), the speeding-up of, even widely known, practices (Gibbons 2004). Adoption by network members is amplified by similarity of characteristics of organizations in networks as similar organizations are evaluated as more relevant and easier to learn from.

Networks can be seen as collective knowledge and information sources (Gulati *et al.* 2002). These sources can be utilized by IOR members to increase their innovation and learning capabilities (Ingram and Baum 1997; Dyer and Nobeoka 2000), or their innovative performance by participating in dense networks that give access to tacit knowledge (Ahuja 2000*b*) or by making use of structural holes in networks which provide novel information (Baum *et al.* 2000) (see also, Nooteboom, Chapter 23 this volume). Empirical evidence indicates that the innovative performance of firms is further strengthened if they are part of networks, which are spatially clustered (Saxenian 1994; Oerlemans and Meeus 2005) (see also, Yeung, Chapter 18 this volume).

As is evidenced by research, network membership impacts on firm survival rates (see also Lomi *et al.*, Chapter 12 this volume). Hager, Galaskiewicz, and Larson (2004) show, for example, that ties have a positive influence on the probabilities of survival of newly founded firms and on firms implementing radical change (Miner *et al.* 1990). Being related to network members with high status affects organizational survival in a positive way (Baum and Oliver 1991) as it increases legitimacy levels. Uzzi's research (1996) showed that firms with a high proportion of embedded ties experienced lower failure rates as compared to firms with mixtures of arm's-length and embedded ties.

There are also indications that relational and structural embeddedness affects firm performance in a positive way. As network ties can be interpreted as signals of quality that confer status on a firm, strong ties could result in higher product (Podolny 1994) or stock prices (Stuart *et al.* 1999). Moreover, ties established as informal financial arrangements give IOR members access to financial resources which enables them to increase financial performance and productivity (Keister 1998). As far as indicators of structural embeddedness are concerned, the research by Powell, Koput and Smith-Doerr (1996) shows that network centrality and alliance experience increased the growth rate of biotechnology start-ups, whereas organizations generate higher returns when they have a broker position between disconnected others (Bae and Gargiulo 2004).

It has to be noted that the majority of the literature is biased towards studying the positive organizational effects of networks. However, networks may also constrain participants and have negative performance effects. Being part of a network might lead to lock-in effects, lowering the informational value of the network (Gomes-Casseres 1994) or increasing inertia and resistance to change (Kim *et al.* 2006). Moreover, network ties also can be conduits for the unintended transfer of valuable knowledge and intellectual capital to other network members (Sampson 2004).

Tie Dynamics and Feedback

One of the most important and interesting discussions in which the IOR phenomenon is closely intertwined with a network approach centres on the fact that the formation or termination will lead at the same time to a change of the overall network. The reason for this is that the structural configuration of a network is defined by the presence and absence of IORs. Consequently, a network approach not only allows, but actually requires, a dynamic perspective. IORs follow a cyclical pattern—network change leads to IOR change, which in turn leads to network change, and so on. Consequently, we expect network dynamics to exert a powerful

influence on IORs and to be an object of study in its own right (see also Cropper and Palmer, Chapter 24 this volume).

Most studies taking a network approach to IORs consider network dynamics to be an important phenomenon, although they do not look at it in a systematic way. For example, Gulati and Gargiulo (1999) propose a model in which the formation of inter-organizational networks is the evolutionary outcome of socially embedded organizational action. Their model provides a systematic link between the social structure of an organizational field—understood in network terms—and the behaviour of organizations within the field. They show the link to be bidirectional. On one hand, the emerging social structure progressively shapes organizational decisions about whether and with whom to create new ties. On the other hand, this social structure is produced by the decisions of individual organizations to establish relations with one another. Gulati and Gargiulo convincingly show that IORs not only result from exogenous drivers such as interdependence but also from exogenous evolutionary dynamics triggered by the very way in which organizations select potential partners. The dialectic between action and structure is at the core of this social process. The propositions formulated by Kenis and Knoke (2002) also show that they expect endogenous dynamics to play an important role. For example, when the density of a field-net is low, so is the tie formation rate. As density increases, the tie formation rate accelerates in response to increased opportunities for collaboration. Finally, as the network reaches saturation, the tie formation rate declines and eventually declines to zero.

Ozcan and Eisenhardt (2006) pointed to the dynamics of clusters in networks. They demonstrated that co-evolution of complementary ties, as a result of simultaneously negotiating with complementary partners and the competition of similar ties, contributes to the structural evolution of the network through the formation and change of clusters. Both forces are opposing because the co-evolution of complementary ties creates a cluster around large and complementary nodes in the network while the competition of similar ties selects out the small nodes and pushes them towards the periphery. This constant push and pull around the large nodes gives the network momentum.

A Critical Evaluation of the Contribution of Network Analysis to the Analysis of IORs

We have seen that while the network perspective is alive in the literature on IORs, only a limited number of issues and phenomena have been addressed. Formation

of ties is the issue that has received the most attention and alliance formation is the phenomenon most studied. This can be good news as it leaves room for unrealized potential, but it could also be bad news because it might be an indication of the limitation of what can be studied with this perspective.

Nevertheless, on the basis of what has been studied so far, we can comfortably say that a network approach has the potential of being important to the study and analysis of IORs. This being said, it is also clear that we are far from having a general network theory of IORs. Although network embeddedness often seems to play a role, almost every study introduces different and new independent variables or introduces intermediary or moderator variables. What we can say with certainty is that the network approach carries us beyond the observation that relationships between actors are simply a result of market rationales, of the interdependence between actors, or of some other actor attribute such as size, age, scope, or resource endowment.

The strength of the network approach is that it cannot only provide an alternative explanation for why actors form ties but also explain with whom actors form ties. Whereas other approaches such as transaction cost economics or resource dependence theory emphasize the fact that organizations create ties to manage environmental uncertainty and to satisfy their resource needs, a network approach is particularly useful in explaining with whom organizations enter such ties and how these actions are related to informational and control benefits.

Another interesting finding is that there is no doubt that actors are always embedded in networks of some kind. Consequently, what must be addressed with a network approach is the type of networks that is most likely to lead to tie formation and tie selection. This implies that the network must be considered as a variable and not only as an alternative governance form. Discussions often revolve around networks, markets, and hierarchies as distinct governance structures, but it is more important to consider the network as a variable, given that they come in all kinds of forms (see Grandori and Soda 1995; Provan and Kenis 2005). Second, besides the presence of actors in networks of a certain form, other conditions seem to determine whether the network variable has an influence or not. Several moderator variables have been identified which determine whether the network in which actors are embedded affects their relational behaviour. For example Beckman, Haunschild, and Philips (2004) have demonstrated that it does make a difference whether an actor forms a new relationship for exploitation or exploration. Actors seem to acknowledge differences between arm's length and embedded ties (Uzzi 1997).

It also becomes clear, however, that the development of a network approach to IOR has to cope with a number of limitations. It seems that empirical studies are biased to such cases where it is easy to operationalize whether an alliance is present or not and whether a given tie occurs or not. For example, this seems to be the main reason why studies of these dependent variables are so prominent in the literature. The question is, of course, to what extent the findings from the alliance literature

can be generalized to other forms of cooperation and coordination between organizations.

Another issue complicating the development of a network approach is that distinguishing between the attributes of organizations and their relational characteristics is a complicating factor in assessing the explanatory strength of such an approach. For example, technological prestige is a network variable because it is engendered by flows of deterrence between firms, and so it has relational foundations (Podolny *et al.* 1996). But the reason for these flows of deterrence is, at least in part, that an organization has contributed an ongoing stream of notable innovations. Hence, the positional variable 'prestige' and the attribute variable 'capability' are closely related.

Another complicating factor might be that the relationship between characteristics of the network and IORs need not be linear, although this is the assumption in most studies. Earlier research has pointed to the possibility of overembeddedness (Burt 1982; Gargiulo and Benassi 2000; Uzzi 1997), which refers to a situation where all firms in a network are connected through strong or embedded ties.

One of the other problems with the explanatory power of a network approach is that it is not always clear where the network starts and where the network ends. For example, is the formation of non-local ties a confirmation or a refutation of the network approach? On one hand one could argue that the simple fact that the relation does not develop within the network disproves the network approach. On the other hand, one could argue that whether an actor is considered to be non-local or not is completely contingent on the definition of the boundaries of the network. It is here where the difference between an embeddedness approach and a network approach becomes clear. An embeddedness perspective is broadly concerned with how social and economic structures govern economic exchanges (Granovetter 1985), whereas a network approach, although based on the same starting point, is at the same time more specific and more general. It is more specific in that it points towards the importance of networks of relationships, which, once formed, shape the establishment of relationships in future periods. It is more general in that it can surpass the embeddedness perspective by including previously non-existing, non-local, or brokerage ties.

In order to continue to formulate a network theory of IORs (e.g., one where specific characteristics of IORs are the result of network characteristics) we must specify how, why, and when we would expect a relationship between attributes of embeddedness and networks and attributes of IORs (Whetten 1989). To conclude we will present some future directions which could be instrumental in such an endeavour. The variation in operationalizations of the independent variable, the network, could be reduced by concentrating on the portfolio of relationships rather than on a single or even a couple of specific relationships. Studies tend to choose different ties in the operationalization of the networks and this reduces comparability between the studies. Portfolios of relationships would be more comparable.

Moreover, Ozcan and Eisenhardt (2006) suggest that the portfolio of relationships has more explanatory power than the individual relationship.

Our review has also shown that the network context which influences the formation, termination, and functioning of IORs can be described along classical network dimensions, in terms of relational, structural, or positional embeddedness or potentially also using the distinction between structural, cognitive, political, and cultural embeddedness proposed by Zukin and DiMaggio (1990). An interesting question then becomes how these different forms of embeddedness are related to each other and whether they have a different explanatory power for the study of IORs. Moreover, Hagedoorn (2006) suggested ordering forms of embeddedness on a vertical dimension. He distinguishes between environmental, network, and dyadic embeddedness and points out that in particular the interactions between these different levels can explain the prevalence of IORs.

Last but not least, a network approach to IORs not only increases our understanding of IORs but also contributes to strengthening the network approach itself. Network research suffers from the conspicuous deficiency that the process of network formation and transformation are underspecified (Emirbayer and Goodwin 1994; Gulati and Gargiulo 1999; Kenis and Knoke 2002; Madhavan *et al.* 1998). Studies tend to apply network-theoretic arguments at the level of the network to explain the generation of future networks. A logical step is to expand these arguments to include the broader set of factors that are likely to influence network formation and to explicitly recognize the motivations and ability of actors in the network (Eisenhardt and Schoonhoven 1996). It is especially at the level of the IOR that these motivations and abilities can be observed and studied.

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